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## **DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]this invention relates to the organic electroluminescence devices used for the light emitting device etc. which are used for various displays, the light source of a display, a back light, or optical communication equipment -- it is.

[0002]

[Description of the Prior Art]Electroluminescence devices are the light-emitting devices using the electroluminescence of the fixed phosphor material called an electroluminescent element or an EL element, Inorganic electroluminescence devices using the present inorganic matter system material as a photogen are put in practical use, and the back light of a liquid crystal display and application deployment to a flat-panel display etc. are achieved partly. However, its voltage for making light emit was as high as more than 100V, and since blue light was moreover difficult for inorganic electroluminescence devices, full-color-izing by the RGB three primary colors was difficult for them.

[0003]On the other hand, although the research on organic electroluminescence devices using organic materials as a photogen also attracted attention for many years and various examination had been performed, luminous efficiency did not result [ from the dramatically bad thing ] in full-fledged practical use research.

[0004]However, the organic electroluminescence which will have a laminated structure of the functional discrete type which divided organic materials into two-layer [ of an electron hole transporting bed and a luminous layer ] by C.W.Tang and others of Kodak in 1987 is proposed, It became clear that the high light emitting luminance more than 1000 cd/m<sup>2</sup> is obtained in spite of the low voltage not more than 10V. And organic electroluminescence devices begin to attract attention after this, and active research came to be done.

[0005]As a result of making such research and development, organic electroluminescence devices are about [ 10V ] low voltages, and luminescence from blue to red of them was attained by the high-intensity surface light about 100 - 100000 cd/m<sup>2</sup> becoming possible, and choosing the kind of fluorescent substance.

[0006]

[Problem(s) to be Solved by the Invention]However, the problem that the luminescence life of the light-hour from high-intensity was short, and preservation durability and reliability were low was among the conventional organic electroluminescence devices developed as mentioned above. Although what was excellent in the hole-injection efficiency from the anode to a luminous layer as a hole transporting material applicable to an electron hole transporting bed in development of organic electroluminescence devices as the reason was developed, In order to raise the electron injection efficiency from the negative pole to a luminous layer, even if it is going to arrange an electron transport layer, An organic compound has little material excellent in electron transport property, the electron injection efficiency from the negative pole to a luminous layer is low, this serves as hindrance of a rise in luminosity and low-voltage-drive-izing, and having led also to aggravation of the life characteristic is mentioned.

[0007]This invention is made in view of the above-mentioned point, and it is high light emitting luminance and

aims at being stabilized for a long time and providing the organic electroluminescence devices in which continuation luminescence is possible.

[0008]

[Means for Solving the Problem]The organic electroluminescence devices 1 concerning claim 1 of this invention comprise the anode 6, the electron hole transporting bed 5, the luminous layer 4, the electron transport layer 3, and the negative pole 2, and a thing containing a n type inorganic compound semiconductor is used for them as the electron transport layer 3.

[0009]In addition to composition of claim 1, at least one thing in a cadmium sulfide, zinc sulfide, or a zinc oxide is used for the organic electroluminescence devices 1 concerning claim 2 of this invention as a n type inorganic compound semiconductor.

[0010]In addition to claim 1 or composition of 2, the organic electroluminescence devices 1 concerning claim 3 of this invention constitute the electron transport layer 3 only from a n type inorganic compound semiconductor.

[0011]In addition to claim 1 or composition of 2, the organic electroluminescence devices 1 concerning claim 4 of this invention constitute the electron transport layer 3 as a laminated structure which consists of n type inorganic compound semiconductor and other electron transport materials, or a mixed layer.

[0012]In addition to one composition of claims 1 thru/or 4, the organic electroluminescence devices 1 concerning claim 5 of this invention change content of a n type inorganic compound semiconductor in the electron transport layer 3 as 0.5-500 nm by thickness conversion.

[0013]In addition to claim 1 or composition of 2, the organic electroluminescence devices 1 concerning claim 6 of this invention form the electron transport layer 3 as a dispersion layer which distributed a n type inorganic compound semiconductor in a high molecular compound.

[0014]In addition to composition of claim 6, the organic electroluminescence devices 1 concerning claim 7 of this invention change considering content of a n type inorganic compound semiconductor in the electron transport layer 3 as 15 to 70 % of the weight.

[0015]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is described.

[0016]If the organic electroluminescence devices 1 concerning this invention are constituted as what the anode 6, the electron hole transporting bed 5, the luminous layer 4, the electron transport layer 3, and the negative pole 2 laminated in order, positive voltage is impressed to the anode 6 and negative voltage is impressed to the negative pole 2 as shown in drawing 1, The electron poured into the luminous layer 4 via the electron transport layer 3 and the electron hole poured into the luminous layer 4 via the electron hole transporting bed 5 recombine within the luminous layer 4, and luminescence takes place.

[0017]It is preferred to use the electrode material which consists of metal with a large work function, an alloy, electrical conductivity compounds, or these mixtures as the anode 6 which is an electrode for pouring in an electron hole into an element. As these electrode materials, it is preferred here that a work function uses a not less than 4-eV thing. As such an electrode material, conductive transparent materials, such as metal, such as gold, CuI, indium tin oxide (ITO), SnO<sub>2</sub>, and ZnO, are specifically mentioned. This anode 6 can produce these

electrode materials by forming in a thin film by methods, such as a vacuum deposition method and sputtering process, on the glass substrate 7, for example.

[0018]When making the anode 6 penetrate and irradiating with luminescence in the luminous layer 4 outside, it is preferred to make light transmittance of the anode 6 into not less than 10%. In below 100ohms / \*\*, it makes sheet resistance of the anode 6 desirable that below hundreds of ohms / \*\* carry out desirable especially. As this sheet resistance is low, it is more desirable, but the minimums on [ in the actual condition ] actual are 10ohm/\*\*.

[0019]The thickness of the anode 6 changes with materials, in order to control the characteristics, such as light transmittance of the anode 6, and sheet resistance, as mentioned above, but it usually makes 500 micrometers or less preferably the range of 10-200 micrometers here.

[0020]As for the negative pole 2 which is an electrode for pouring in an electron into an element on the other hand, it is preferred to use the electrode material which consists of the small metal of a work function, an alloy, electrical conductivity compounds, or these mixtures. As these electrode materials, it is preferred here that a work function uses a thing of 5 eV or less. As such an electrode material, specifically For example, sodium, a sodium potassium alloy, Lithium, magnesium, aluminum, a magnesium silver mixture, a magnesium indium mixture, an aluminium-lithium alloy, an aluminum/aluminum<sub>2</sub>O<sub>3</sub> mixture, an aluminum/LiF mixture, etc. are mentioned. This negative pole 2 can produce these electrode materials by forming in a thin film by methods, such as a vacuum deposition method and sputtering process, for example.

[0021]When making the negative pole 2 penetrate and irradiating with luminescence in the luminous layer 4 outside, it is preferred to make light transmittance of the negative pole 2 into not less than 10%.

[0022]The thickness of the negative pole 2 changes with materials, in order to control the characteristics, such as light transmittance of the negative pole 2, as mentioned above, but it usually makes 500 micrometers or less preferably the range of 10-200 micrometers here.

[0023]As the luminescent material or doping materials which can be used for the luminous layer 4, Anthracene, naphthalene, pyrene, tetracene, coronene, perylene, Phtalo perylene, naphthalo perylene, diphenylbutadiene, tetraphenylbutadiene, Although there are a coumarin, oxadiazole, screw benzo KISAZORIN, screw styryl, a cyclopentadiene, a quinoline metal complex, an aminoquinoline metal complex, a benzoquinoline metal complex, Piran, Quinacridone, rubrene, a fluorochrome, etc., it is not limited to these. The luminous layer 4 can consist of only luminescent materials chosen from among these compounds. the luminescent material chosen from among these compounds -- 90 to 99.5 weight section, the doping materials 0.5 - 10 weight-section \*\*\*\* -- it is also preferred to make it like. 0.5-500 nm of thickness of this luminous layer 4 shall be 0.5-200 nm still more preferably.

[0024]As a hole transporting material which constitutes the electron hole transporting bed 5, have the capability to convey an electron hole, and it has the hole-injection effect from the anode 6, and the compound which prevented movement to the electron hole transporting bed 5 of the electron which has the hole-injection effect outstanding to the luminous layer 4 or the luminescent material, and was generated by the luminous layer 4, and was excellent in thin-film-forming capability is mentioned. Specifically A phthalocyanine derivative, a naphthalocyanine derivative, a porphyrin derivative, Oxazol, oxadiazole, triazole, imidazole, imidazolone, Pyrazoline, tetrahydro imidazole, a poly aryl alkane, butadiene, Although polymer materials, such as a benzidine type triphenylamine, a styryl amine type triphenylamine, a diamine type triphenylamine, etc. those derivatives and a polyvinyl carbazole, polysilane, and a conductive polymer, are mentioned, it is not limited to these.

[0025]If glass transition temperature is high and especially the electron hole transporting bed 5 is constituted from an organic compound in which crystallization does not take place easily, it will be long-life and the organic electroluminescence devices 1 excellent in heat resistance will be obtained.

[0026]For the purpose of reducing the hole-injection barrier between the anode 6 and the electron hole transporting bed 5. As a hole transporting material, if a phthalocyanine derivative, the third class of aromatic amine, such as a 4,4',4''-tris(3-methylphenyl phenylamino) triphenylamine (m-MTDATA), etc. are used, the reduction effect of driver voltage will become large.

[0027]If an electronic acceptance substance is added to a hole transporting material, the carrier density in the electron hole transporting bed 5 can go up, electron hole transportability can be improved, and light emitting luminance can be improved.

[0028]In this invention, the thing containing a n type inorganic compound semiconductor is used as the electron transport layer 3. If it does in this way, can raise the electron injection efficiency from the negative pole 2 to the luminous layer 4, and the rise in luminosity of the organic electroluminescence devices 1 will be attained, and the prolonged drive nature of the light-hour from high-intensity can be improved. Especially as a n type inorganic compound semiconductor, although not limited, it is preferred to use a cadmium sulfide, zinc sulfide, a zinc

oxide, or two or more sorts of mixtures of these. These compounds can have high electron affinity, and their electron transportation ability can be high, and they can be simply formed by vacuum deposition method, sputtering process, etc.

[0029]Can form the electron transport layer 3 only with the n type above inorganic compound semiconductors, and at this time thickness, Forming in 0.5-500 nm is preferred, if thickness is less than 0.5 nm, there are few effects of improvement in the electron injection efficiency from the negative pole 2 to the luminous layer 4, and when it exceeds 500 nm, there is a possibility that increase of impressed electromotive force and problems, such as a luminous efficiency fall, may occur.

[0030]A n type inorganic compound semiconductor and other electron transport materials can also constitute the electron transport layer 3.

[0031]as other electron transport materials, have the capability to convey an electron, and it has the electron injection effect from the negative pole 2, and the compound which prevented movement to the electron transport layer 3 of the electron hole which has the electron transportation effect outstanding to the luminous layer 4 or the luminescent material, and was generated by the luminous layer 4, and was excellent in thin-film-forming capability is mentioned. Although a fluorene, anthra quinodimethane, diphenquinone, oxazol, oxadiazole, triazole, imidazole, anthra quinodimethanes, etc. and those derivatives are specifically mentioned, it is not limited to these.

[0032]In the organic electroluminescence devices 1 of this invention, a metal complex compound or a nitrogen-containing 5 member derivative is mentioned as other still more effective electron transport materials. As a metal complex compound, specifically Tris(8-hydroxyquinolate)aluminium, Tris(2-methyl-8-hydroxyquinolate) aluminum, Tris(8-hydroxyquinolate) gallium, bis(10-hydroxybenzo [h] quinolate)beryllium, Although bis(10-hydroxybenzo [h] quinolate)zinc, bis(2-methyl-8-quinolate)(o-cresolate) gallium, bis(2-methyl-8-quinolate) (1-naphtho RATO) aluminum, etc. can be mentioned, It is not limited to these things. As a nitrogen-containing 5 member derivative, oxazol, a thiazole, oxadiazole, thiadiazole, or a triazole derivative has it, and specifically, [ preferred ] 2,5-bis(1-phenyl)-1,3,4-oxazol, a 2,5-bis(1-phenyl)-1,3,4-thiazole, 2,5-bis(1-phenyl)-1,3,4-oxadiazole, 2-(4'-tert-buthylphenyl)-5-(4"-biphenyl)-1, 3, 4-oxadiazole, 2,5-bis(1-naphthyl)-1,3,4-oxadiazole, 1,4-bis[2- (5-phenyl thiadiazolyl)] benzene, Although 2,5-bis(1-naphthyl)-1,3,4-triazole, 3-(4-biphenyl)-4-phenyl-5-(4-tert-buthylphenyl)-1,2,4-triazole, etc. are mentioned, it is not limited to these.

[0033]If it is also preferred to add an electron-donative substance to other above-mentioned electron transport materials and it is done in this way, the electron density in the electron transport layer 3 is improved, electron transport property is improved, and electron flow becomes smooth and can improve light emitting luminance.

[0034]In constituting the electron transport layer 3, with a n type inorganic compound semiconductor as shown above, and other electron-transport-property materials, The electron transport layer 3 can be formed in the laminated structure of the layer which consists of a n type inorganic compound semiconductor, and the layer which consists of other electron transport materials, and it can also form as a mixed layer which mixes other electron transport materials with a n type inorganic compound semiconductor.

[0035]The layer which consists of a n type inorganic compound semiconductor when forming the electron transport layer 3 in a laminated structure, if the layer which consists of other electron transport materials is arranged so that the larger one of electron affinity may become the negative pole 2 side preferably, and it is carried out in this way, the electron injection efficiency from the negative pole 2 to the electron transport layer 3 will be improved, and electron transport property will be improved -- it can carry out. At this time, it is preferred to form the thickness of 0.5-500 nm and the electron transport layer 3 whole in 0.5-800 nm for the thickness of the layer which consists of a n type inorganic compound semiconductor. If the thickness of the layer which consists of a n type inorganic compound semiconductor is less than 0.5 nm, there are few effects of improvement in the electron injection efficiency from the negative pole 2 to the luminous layer 4, and when it exceeds 500 nm, there is a possibility that increase of impressed electromotive force and problems, such as a luminous efficiency fall, may occur.

[0036]As for the loadings of the n type inorganic compound semiconductor contained in a mixed layer, when forming the electron transport layer 3 as a mixed layer, it is preferred to be referred to as 0.5-500 nm by thickness conversion. As for the thickness of the whole mixed layer, it is preferred to be referred to as 0.5-800 nm. Thickness conversion is the quantity converted into the thickness of the layer which consists of this n type inorganic compound semiconductor at the time of assuming that the layer which consists of a n type inorganic compound semiconductor in the electron transport layer 3 of a laminated structure with the n type inorganic compound semiconductor contained in a mixed layer is formed here. If the loadings in thickness conversion of the layer which consists of a n type inorganic compound semiconductor are less than 0.5 nm, there are few effects of improvement in the electron injection efficiency from the negative pole 2 to the luminous layer 4, and when it exceeds 500 nm, there is a possibility that increase of impressed electromotive force and problems, such as a luminous efficiency fall, may occur.

[0037]The electron transport layer 3 can also be formed as a dispersion layer which distributed the n type above-mentioned inorganic compound semiconductor in the high molecular compound. As a high molecular compound which can be used at this time, polystyrene, polycarbonate, Polyarylate, polyester, polyamide, polyurethane, polysulfone, Conductive polymers, such as photo electroconductive polymer, such as insulating high molecular compounds, such as polymethylmethacrylate, polymethyl acrylate, and cellulose, poly-N-vinylcarbazole, and polysilane, a polythiophene, and polypyrrole, etc. can be mentioned.

[0038]In forming the electron transport layer 3 as a dispersion layer, After making a high molecular compound distribute a n type inorganic compound semiconductor, suitable solvents, such as chloroform, 1,2-dichloroethane, a tetrahydrofuran, and dioxane, can be added, and dispersion liquid can be prepared, for example, it can form by the wet forming-membranes methods, such as the spin coating method and a dipping method, etc.

[0039]The loadings of the n type inorganic compound semiconductor in the electron transport layer 3 formed as the above-mentioned dispersion layer, It is preferred to consider it as 15 to 70 % of the weight, unless it fills to 15% of the weight, the electron transportation performance from the negative pole 2 to the luminous layer 4 is not fully obtained, but if it exceeds 70 % of the weight, the viscosity of the dispersion liquid at the time of forming membranes will become high too much, and it will become difficult to obtain a uniform thin film. Being referred to as 5-1000 nm sets desirable still more preferably to 5-500 nm thickness of the electron transport layer 3 formed as a dispersion layer.

[0040]In producing the organic electroluminescence devices 1 of this invention with the above materials, after forming the anode 6 with sputtering process, a vacuum deposition method, etc. on the glass substrate 7, the electron hole transporting bed 5 and the luminous layer 4 are formed by vacuum deposition method, sputtering process, etc. one by one, for example. And when forming the electron transport layer 3 as a monolayer of a n type inorganic compound, the electron transport layer 3 is formed by methods, such as a vacuum deposition method or sputtering process, with a n type inorganic compound semiconductor following formation of the luminous layer 4. When forming the electron transport layer 3 as a laminated structure, after forming one of the layer of a n type inorganic compound semiconductor, and the layers of other electron transport materials by vacuum deposition method, sputtering process, etc. following formation of the luminous layer 4, another side is formed by vacuum deposition method, sputtering process, etc. When forming the electron transport layer 3 as a mixed layer, the electron transport layer 3 is simultaneously formed for a n type inorganic compound semiconductor and other electron transport materials by vacuum deposition method, sputtering process, etc. following formation of the luminous layer 4. And the negative pole 2 can be formed by methods, such as a vacuum deposition method and sputtering process, after formation of the electron transport layer 3. Thus, when forming the electron transport layer 3 as n type monolayer, laminated material, or mixture of an inorganic compound semiconductor, Two or more layers which constitute the organic electroluminescence devices 1 can be continuously formed within the same vacuum housing etc. by methods, such as a vacuum deposition method and sputtering process, and productive efficiency is good.

[0041]When forming the electron transport layer 3 as a dispersion layer, the electron transport layer 3 is formed

by the wet forming-membranes methods, such as the spin coating method and a dipping method, etc. following formation of the luminous layer 4. And the negative pole 2 can be formed by methods, such as a vacuum deposition method and sputtering process, after formation of the electron transport layer 3. Thus, by forming the electron transport layer 3 as a dispersion layer, the electron transport layer 3 containing a n type inorganic compound semiconductor can be formed according to application processes, such as the wet forming-membranes method. At this time, the electron hole transporting bed 5, the luminous layer 4, and the electron transport layer 3 can also be altogether formed by the wet forming-membranes methods, such as the spin coating method and a dipping method, etc.

[0042]After doing in this way and performing formation of the anode 6, the electron hole transporting bed 5, the luminous layer 4, the electron transport layer 3, and the negative pole 2, in order to improve the stability to temperature, humidity, atmosphere, etc., After making an element surface carry out spreading hardening of the resin composition prepared by blending fillers, such as silica gel powder, with silicone series adhesives and providing a protective layer in it, It is also possible to enclose a silicone oil etc. between a glass substrate and an element in the state where used the epoxy resin etc. for the element outside surface, and pasted the glass substrate together to it, or the glass substrate has been arranged on the element outside surface if needed, and to protect an element.

[0043]The organic electrolysis light emitting device 1 constituted as mentioned above can attain high light-emitting-luminance-ization, can obtain usable luminosity practical by low driver voltage, and can also reduce substantially degradation at the time of a long term drive. The organic electrolysis light emitting device 1 concerning this invention can consider the application to light sources, such as a copying machine and a printer, the light source of a liquid crystal display or instruments, the plotting board, a sign, etc. as flat-panel displays, such as a flat TV, and a plane emitter, and its industrial value is very large.

[0044]

[Example]Hereafter, although this invention is explained in full detail according to an example, this invention is not restricted to the following example.

[0045]As a hole transporting material, N,N'-bis(3-methylphenyl)-(1-1'-biphenyl)-4,4'-diamine. (It is hereafter called TPD for short.) [made in Tokyo Chemicals] -- as a luminescent material -- Aluminum (8-hydroxy kino linon) (it is hereafter called Alq3 for short.) [-- Dojin Chemical Laboratory] was used. As an electron transport material, with the composition shown in Table 1, as a n type inorganic compound semiconductor A cadmium sulfide [Kojundo Chemical Laboratory Make], Zinc sulfide [Kojundo Chemical Laboratory Make] and a zinc oxide [Kojundo Chemical Laboratory Make] as other electron transport materials, 3-(4-biphenyl)-4-phenyl-5-(4-tert-buthylphenyl)-1,2,4-triazole. (It is hereafter called TAZ for short.) As a high molecular compound, polycarbonate [made in Teijin Chemicals and trade name pan light K-1300] was used for [Dojin Chemical Laboratory Make].

[0046](Example 1) After cleaning this ultrasonically for 20 minutes by neutral detergent, pure water, acetone, and ethanol, it was made to dry using the ITO glass electrode [Matsunami glass] which carried out vacuum deposition of the ITO to the 1-mm-thick glass substrate 7, and formed the anode 6 of 50ohms of sheet resistance / \*\*. This ITO glass electrode was fixed to the substrate holder of a commercial vacuum evaporator [product made from TOKUDA]. On the other hand, three resistance heating boats made from molybdenum were prepared, it put at a time into each 100 mg of cadmium sulfides which are TPD, Alq3, and a n type inorganic compound semiconductor, and the inside of a vacuum chamber was decompressed to  $1 \times 10^{-5}$  Torr. And membranes were formed to 50-nm thickness with the evaporation rate of 0.2 nm/s, heating the resistance heating board into which TPD was put first, and monitoring by a crystal oscillator thickness gage. Then, the resistance heating boat of Alq3 entering was heated and membranes were formed to 50-nm thickness on the same conditions. The resistance heating boat containing a cadmium sulfide was heated, and membranes were formed to 5-nm thickness on the same conditions. After taking this out from the vacuum chamber and providing the mask made from stainless steel, it attached to the substrate holder again. On the other hand, Li content put 1% of

the weight of aluminum-Li alloys [ 1g of ] into the tungsten filament, and decompressed the inside of a vacuum chamber to  $1 \times 10^{-5}$  Torr to it. And the tungsten filament is heated, membranes were formed to 150-nm thickness with the evaporation rate of 1 nm/s, the negative pole 2 was formed, and the organic electroluminescence devices 1 were produced.

[0047](Example 2) As a n type inorganic compound semiconductor, except having used zinc sulfide instead of the cadmium sulfide, it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

[0048](Example 3) As a n type inorganic compound semiconductor, except having used the zinc oxide instead of the cadmium sulfide, it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

[0049](Example 4) Except having formed the thickness of the electron transport layer 3 in 80 nm, it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

[0050](Example 5) The cadmium sulfide was used as a n type inorganic compound semiconductor, TAZ was used as other electron transport materials, these were put into the resistance heating board made from molybdenum, respectively, and it put into the vacuum chamber with the hole transporting material and the luminescent material. And in formation of the electron transport layer 3, the resistance heating board into which TAZ was put first is heated, After forming in 5-nm thickness the layer which consists of TAZ(s) with a vacuum deposition method with the evaporation rate of 0.2 nm/s, By forming in 5-nm thickness the layer which heats the resistance heating board into which the cadmium sulfide was put, and consists of cadmium sulfides with vacuum deposition with the evaporation rate of 0.2 nm/s, the electron transport layer 3 of the laminated structure was formed. Except it, it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

[0051](Example 6) The cadmium sulfide was used as a n type inorganic compound semiconductor, TAZ was used as other electron transport materials, these were put into the resistance heating board made from molybdenum, respectively, and it put into the vacuum chamber with the hole transporting material and the luminescent material. And in formation of the electron transport layer 3, the resistance heating board containing a cadmium sulfide and the heating board containing TAZ are heated simultaneously, The electron transport layer 3 of the mixed layer which carries out vacuum deposition simultaneously with both the evaporation rates of 0.2 nm/s, and contains 5 nm of cadmium sulfides by thickness conversion and whose total thickness is 10 nm was formed. Except it, it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

[0052](Example 7) What was performed to the anode 6 to formation of the luminous layer 4 was taken out from the vacuum chamber, and it fixed on the spin coater. Made in [ which is a high molecular compound on the other hand about the cadmium sulfide which is a n type inorganic compound semiconductor ] polycarbonate [Teijin Chemicals, Trade name Into pan light K-1300], the spin coat was performed for what made it distribute at 20% of the weight of a rate, and distributed this thing in 1,2-dichloromethane further on the surface of the luminous layer 4 on 1500-rpm conditions, and the electron transport layer 3 of 70 nm of thickness was formed. Except it, it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

[0053](Example 8) What was performed to the anode 6 to formation of the luminous layer 4 was taken out from the vacuum chamber, and it fixed on the spin coater. Made in [ which is a high molecular compound on the other hand about the cadmium sulfide which is a n type inorganic compound semiconductor ] polycarbonate [Teijin Chemicals, Trade name Into pan light K-1300], the spin coat was performed for what made it distribute at 50% of the weight of a rate, and distributed this thing in 1,2-dichloromethane further on the surface of the luminous layer 4 on 1500-rpm conditions, and the electron transport layer 3 of 80 nm of thickness was formed. Except it, it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

(Comparative example 1) The electron transport layer 3 was not formed, but except having made the luminous layer 4 use also [ electron transport layer / 3 ], it carried out like Example 1 and the organic electroluminescence devices 1 were produced.

[0054](Evaluation test) The organic electroluminescence devices 1 of each example and a comparative example produced as mentioned above under a dry nitrogen atmosphere, Negative voltage was impressed to the electrode

which turns into an ITO glass electrode which is the anode 6 from the aluminum-Li alloy which is the negative pole 2 in positive voltage, and the light emitting luminance of luminescence irradiated outside via the glass substrate 7 in the impressed electromotive force 8V was measured.

[0055]The maximum luminance at the time of raising continuously the voltage impressed to the organic electroluminescence devices 1 under a dry nitrogen atmosphere was measured.

[0056]Constant current was sent through the organic electroluminescence devices 1 on condition of current density  $10 \text{ mA/cm}^2$  under a dry nitrogen atmosphere, the direct-current continuation drive was carried out by initial light-emitting-luminance [ of  $100 \text{ cds/m}^2$  ], time (luminosity half line) until light emitting luminance is halved to 50% of initial light emitting luminance was measured, and continuation drive nature was evaluated.

[0057]Measurement of luminosity was performed here using the luminance meter [product made from TOPCON, and lot number BM-7].

[0058]The above result is shown in Table 1.

[0059]

[Table 1]

		実施例								比較例
		1	2	3	4	5	6	7	8	1
正孔輸送層	正孔輸送材料	TPD	←	←	←	←	←	←	←	←
	膜厚(nm)	50	50	50	50	50	50	50	50	50
発光層	発光材料	Alq3	←	←	←	←	←	←	←	←
	膜厚(nm)	50	←	←	←	←	←	←	←	←
電子輸送層	n型無機化合物半導体	CdS	ZnS	ZnO	CdS	←	←	←	←	—
	膜厚(nm)	5	5	5	80	5	5	—	—	—
	分散濃度	—	—	—	—	—	—	20	50	—
	他の電子輸送材料	—	—	—	—	TAZ	←	—	—	—
	膜厚(nm)	—	—	—	—	5	5	—	—	—
	高分子化合物	—	—	—	—	—	—	ポリカーボネート	←	—
	構成	単層	←	←	←	積層	混合層	分散層	分散層	—
	総膜厚(nm)	5	5	5	80	10	10	70	80	—
輝度 ( $\text{cd/m}^2$ )	(at 8V)	8000	6500	6200	11000	10000	11000	6500	7500	4000
	最大輝度	20000	18000	17000	21000	23000	23000	16000	18000	10000
輝度半減時間(h:at $10 \text{ mA/m}^2$ )		200	350	330	250	400	400	100	90	30

[0060]In Examples 1-8, it has checked that the light emitting luminance in 8V was high, maximum luminance was also high, and also continuation drive nature was also higher than the comparative example 1 which does not form the electron transport layer 3 containing a n type inorganic compound semiconductor so that clearly from Table 1.

[0061]

[Effect of the Invention]The organic electroluminescence devices built over claim 1 of this invention as mentioned above comprise the anode, an electron hole transporting bed, a luminous layer, an electron transport layer, and the negative pole, and the thing containing a n type inorganic compound semiconductor is used for them as an electron transport layer.

Can raise the electron injection efficiency from the negative pole to a luminous layer, and the rise in luminosity of organic electroluminescence devices is attained, and the prolonged drive nature of the light-hour from high-intensity can be improved.

[0062]In addition to the composition of claim 1, at least one thing in a cadmium sulfide, zinc sulfide, or a zinc oxide is used for the organic electroluminescence devices concerning claim 2 of this invention as a n type



inorganic compound semiconductor.

Since these compounds have high electron affinity and their electron transportation ability is high, they can raise the electron injection efficiency from the negative pole to a luminous layer, and can be simply formed by vacuum deposition method, sputtering process, etc.

[0063]In addition to claim 1 or the composition of 2, the organic electroluminescence devices concerning claim 3 of this invention constitute an electron transport layer only from a n type inorganic compound semiconductor. Can raise the electron injection efficiency from the negative pole to a luminous layer in the electron transport layer which comprises only a n type inorganic compound semiconductor, and the rise in luminosity of organic electroluminescence devices is attained, and the prolonged drive nature of the light-hour from high-intensity can be improved.

[0064]In addition to claim 1 or the composition of 2, the organic electroluminescence devices concerning claim 4 of this invention constitute an electron transport layer as the laminated structure which consists of n type inorganic compound semiconductor and other electron transport materials, or a mixed layer. Can raise the electron injection efficiency from the negative pole to a luminous layer in the electron transport layer which consists of a n type inorganic compound semiconductor and other electron transport layers, and the rise in luminosity of organic electroluminescence devices is attained, and the prolonged drive nature of the light-hour from high-intensity can be improved.

[0065]In addition to one composition of claims 1 thru/or 4, the organic electroluminescence devices concerning claim 5 of this invention set content of the n type inorganic compound semiconductor in an electron transport layer to 0.5-500 nm by thickness conversion. The effect of improvement in the electron injection efficiency from the negative pole to a luminous layer and the effect which controls increase of impressed electromotive force and a luminous efficiency fall can be acquired with sufficient balance.

[0066]In addition to claim 1 or the composition of 2, the organic electroluminescence devices concerning claim 6 of this invention form an electron transport layer as a dispersion layer which distributed the n type inorganic compound semiconductor in the high molecular compound. An electron transport layer can be formed by the wet forming-membranes method.

[0067]In addition to the composition of claim 6, the organic electroluminescence devices concerning claim 7 of this invention make content of the n type inorganic compound semiconductor in an electron transport layer 15 to 70 % of the weight. The electron transportation performance from the negative pole to a luminous layer is fully obtained, and it can control that the viscosity of the dispersion liquid at the time of forming membranes becomes high too much, and can form in a uniform thin film by the wet forming-membranes method.

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[Translation done.]